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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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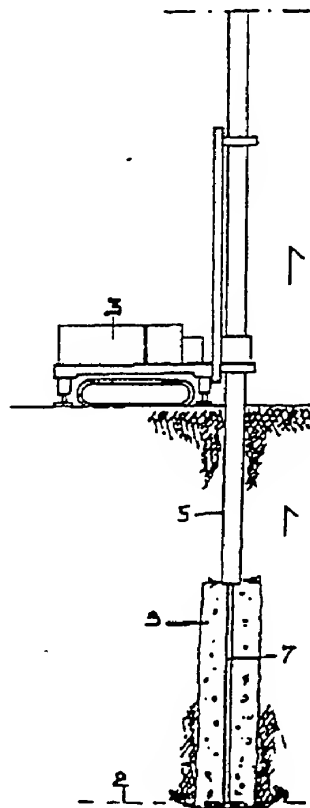
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(54) Title: A PROCEDURE FOR THE FORMING OF CONSOLIDATION AND FOUNDATION PILES WITH EMBEDDED REINFORCEMENTS

## (57) Abstract

The art field is that of casting consolidation and foundation piles in-situ using ultra-high pressure liquid concrete injection casting methods; in the procedure disclosed, a metal reinforcement (7) is positioned prior to effecting the cast.



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A procedure for the forming of consolidation and foundation piles with embedded reinforcements

The invention relates to a procedure for in-situ casting of consolidation and foundation piles with embedded reinforcements.

05 The prior art embraces methods of consolidating the soil that consist essentially in preparing a liquid mix of concrete and binders and injecting it into the ground at ultra-high pressure.

The mix is injected by sinking a rod into the earth to the envisaged consolidation depth.

10 Such a rod is provided with a special boring head, and with a injection valve carrying one or more nozzles disposed at right angles to the rod axis, substantially within the same transverse plane. The rod is mounted to a device by which it is rotated  
15 and traversed along its own axis.

Ultra-high pressure injection of the mix occurs as the rod is withdrawn, rotating about its axis.

The conventional method thus outlined is beset by certain drawbacks in given applications such as  
20 those, for example, where a reinforcement has to be

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embedded axially in the concrete.

This is achieved, conventionally, by casting the consolidation pile and then positioning tubular or other reinforcing members in a separate operation: such a procedure involves a considerable waste of time, and cannot ensure coaxial alignment between the reinforcement and the cast; the reinforcement can in fact become deflected uncontrollably during the positioning step, occasioning a subsequent loss of performance in terms of strength specifications. In a procedure set forth by the same applicant, use is made of a pipe, perforated with a plurality of uniformly distributed radial holes extending down to the envisaged consolidation depth. The pipe is planted in the ground, and the liquid concrete mix injected at high pressure, in such a way that the pipe remains embedded in a column of concrete and soil created by the turbulence of the injection. The in-situ casting of consolidation piles with embedded reinforcements is simplified considerably by adoption of such a system; on the other hand, the pipe is costly, by reason of the need for a uniform perforation, and cannot be recovered. Accordingly, the object of the invention is to set forth a procedure that will permit of positioning

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any given reinforcement of tubular or cage type embodiment in a consolidation pile cast in-situ using high pressure injection techniques, ensuring coaxial alignment between the reinforcement and the cast, and of accomplishing such operations swiftly and inexpensively.

The stated object is achieved by adoption of a procedure as characterized in the appended claims. The invention will now be described in detail, by way of example, with the aid of the accompanying drawings, in which:

figs 1...4 illustrate four steps of the casting procedure disclosed;

figs 5 and 6 are sectional illustrations of the consolidation pile showing two different types of reinforcement;

figs 7 and 8 are sectional illustrations of the consolidation pile showing two different types of pipe, seen during the withdrawal step.

With reference to fig 1 of the drawings, the first step of the procedure is that of sinking a bore in the ground 1 down to a prescribed consolidation depth 2, using conventional mechanical equipment 3 by means of which a pipe 5 is driven straight into the soil, traversing along its own axis.

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6 denotes a rotatable rod inserted into the pipe 5, the end of which carries a drill head. With the spoil removed and the pipe 5 firmly in position, the rod 6 is withdrawn (fig 2), and the pipe left in place.

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The side wall of the pipe 5 is perforated to enable the passage of liquid concrete from inside to outside, as will occur in a subsequent step of the procedure.

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The third step of the procedure (fig 3) consists in positioning a reinforcement 7 in the bore; such a reinforcement might be tubular, as illustrated in fig 5, or composed of single bars or wires arranged to coincide with the generators of an imaginary cylinder (fig 6).

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The final step of the procedure is one of pumping liquid concrete into the bore at high pressure and withdrawing the perforated pipe 5 at one and the same time, thereby consolidating the soil around a pile 9 in which the reinforcement 7 remains firmly embedded.

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Fig 7 illustrates a pipe 5a affording an annular cavity, whereas the pipe 5b illustrated in fig 8 affords a set of channels arranged to coincide with generators of the pipe.

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05 It will be clear that the procedure as described above admits of embedding any type of reinforcement in a cast-in-situ pile, in contrast to conventional procedures, which permit of embedding bars or wires only, and to relatively shallow depths.

The reinforcement might be embodied as a cage, or tubular, or as a rod, or indeed as a simple pole, without any difficulty as regards its embedding in and alignment with the cast.

10 Casting pressure may vary between 300 and 800 bar, according to requirements, without affecting the position of the reinforcement inside the pipe 5. The cavity of a pipe 5 as in fig 7 can be used to pump in back-fill material or to pump out spoil:

15 materials pumped in could be concrete, mortar or any filling considered suitable for the purpose; in the case of materials pumped out, control will be provided over any excess pressure occasioned by the high injection pressure and disposal of the spoil.

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# Claims

- 1) A procedure for the forming of consolidation and foundation piles with embedded reinforcements, characterized in that it comprises the steps of:
  - simultaneously sinking a pilot bore in the ground to a prescribed consolidation depth by means of conventional implements, and driving an ultra-high pressure liquid concrete injection pipe (5) down the bore to the same depth;
  - withdrawing the implements used to sink the bore, and leaving the pipe (5) driven into the ground;
  - positioning a reinforcement (7) internally of the pipe (5), down to a prescribed depth;
  - simultaneously injecting a liquid concrete mix through the pipe (5) into the bore at ultra-high pressure, and withdrawing the pipe from the ground.
- 2) A procedure as in claim 1, wherein the final step of injecting liquid concrete mix is effected at ultra-high pressure of between 200 and 800 bar.



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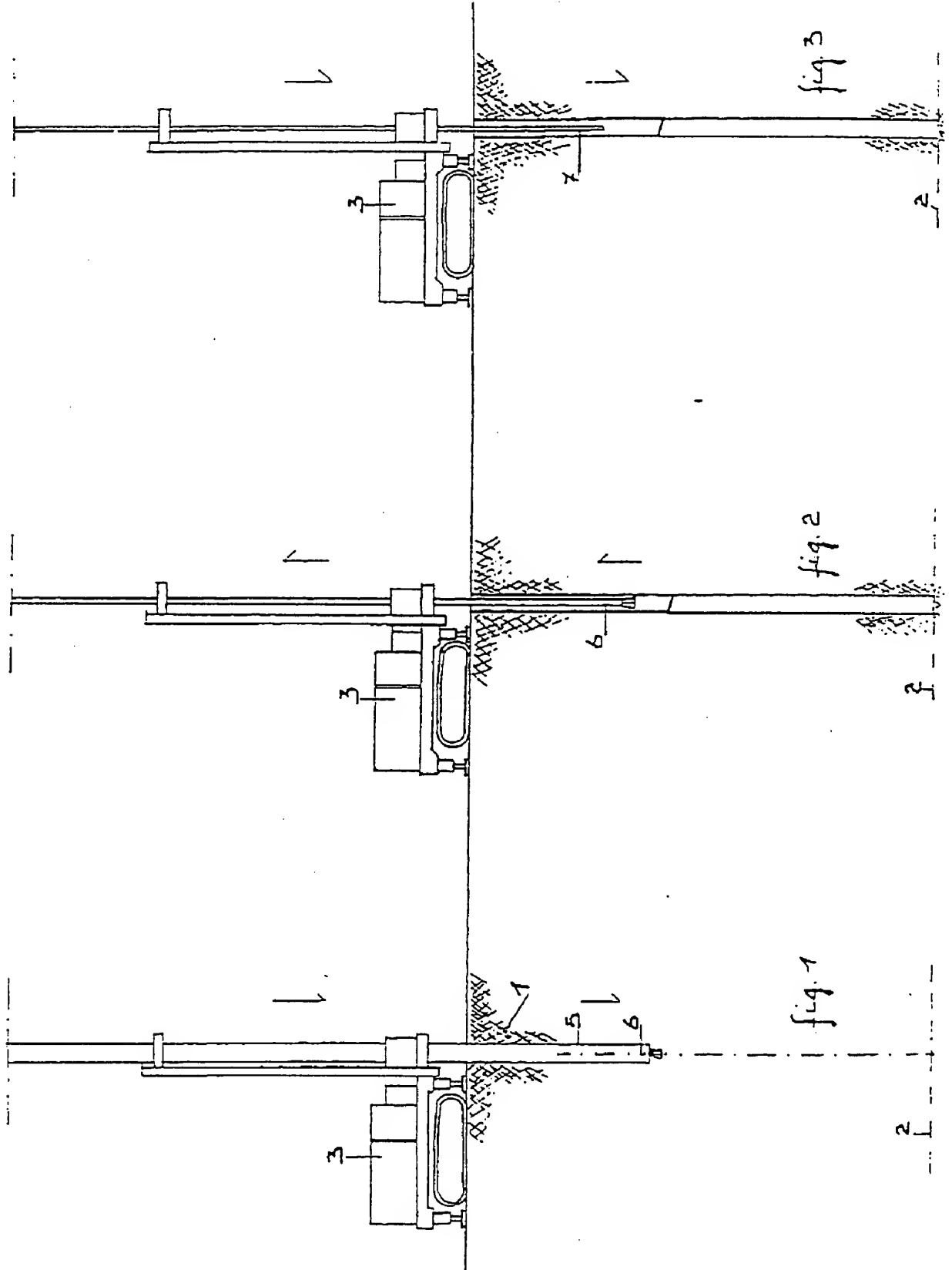
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- 3) A procedure as in claim 1, wherein the internally positioned reinforcement (7) is of tubular type embodiment.
- 4) A procedure as in claim 1, wherein the internally positioned reinforcement (7) is of sectional type embodiment.
- 5) A procedure as in claim 1, wherein the internally positioned reinforcement (7) is of mesh type embodiment.
- 6) A procedure as in claim 1, wherein the internally positioned reinforcement (7) is of lattice type embodiment.
- 7) A procedure as in claim 1, wherein the internally positioned reinforcement (7) is of cage type embodiment.

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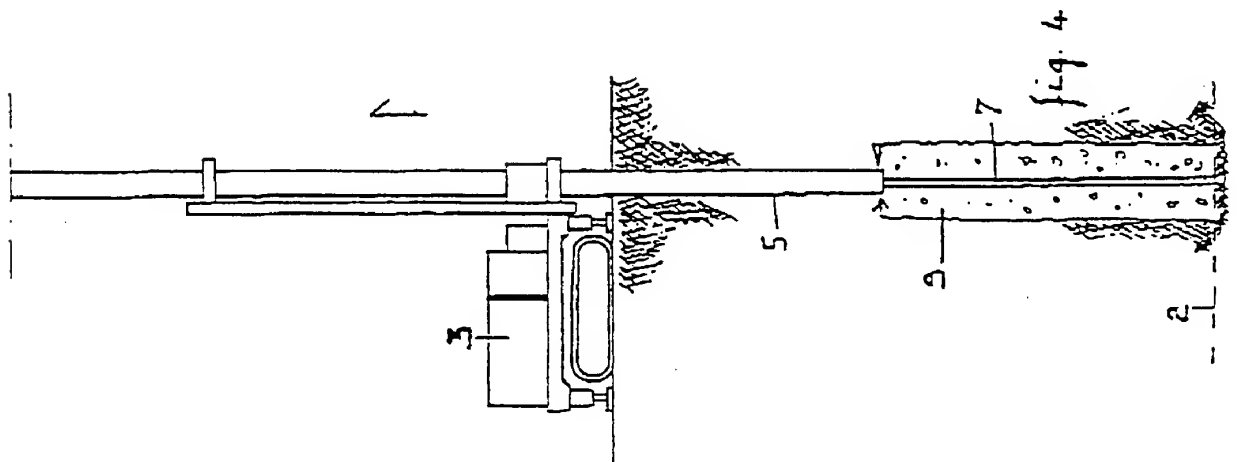
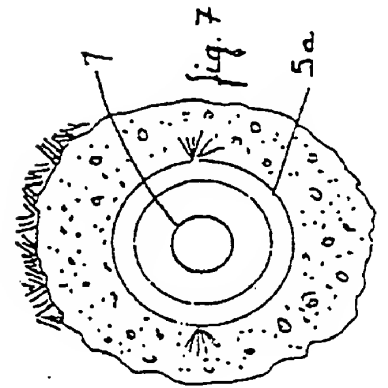
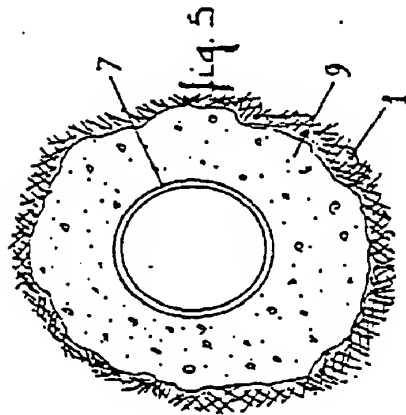
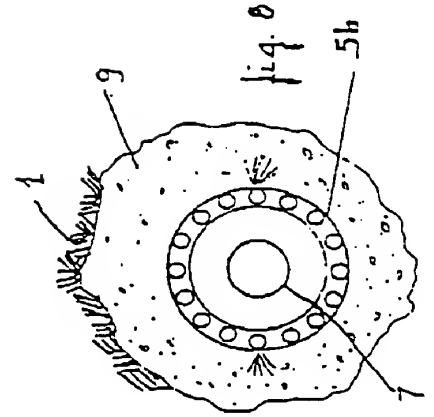
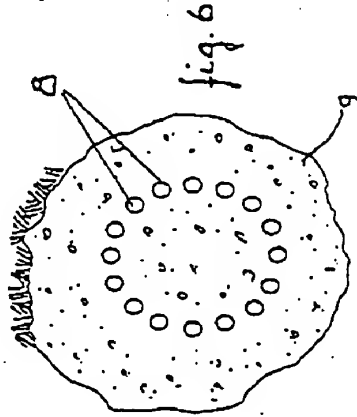
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# INTERNATIONAL SEARCH REPORT

International Application No PCT/IT 89/00020

| <b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) *<br>According to International Patent Classification (IPC) or to both National Classification and IPC<br>IPC <sup>5</sup> : E 02 D 5/46   |  |                                     |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
|---|--|-------------------------------------|--|---|---|--|--|-----|---|--|-----|---|--|-----|---|--|--|
| <b>II. FIELDS SEARCHED</b><br>Minimum Documentation Searched *<br><table border="1"> <tr> <th>Classification System</th> <th>Classification Symbols</th> </tr> <tr> <td>IPC<sup>5</sup></td> <td>E 02 D 5/00, E 02 D 15/00</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *  |  |                                     | Classification System  | Classification Symbols  | IPC <sup>5</sup>  | E 02 D 5/00, E 02 D 15/00                      |  |     |   |  |     |   |  |     |   |  |  |
| Classification System   | Classification Symbols   |                                     |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| IPC <sup>5</sup>  | E 02 D 5/00, E 02 D 15/00  |                                     |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| <b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <table border="1"> <tr> <th>Category *</th> <th>Citation of Document, ** with Indication, where appropriate, of the relevant passages <sup>12</sup></th> <th>Relevant to Claim No. <sup>13</sup></th> </tr> <tr> <td>X</td> <td>DE, A, 2120691 (C. JEBENS) 9 November 1972, see page 7, line 6 - page 8, line 15; claim 1; figures 1-5</td> <td>1-7</td> </tr> <tr> <td>X</td> <td>EP, A, 0151389 (STUMP BOHR GMBH) 14 August 1985, see page 5, lines 1-7; page 13, line 19 - page 14, line 20; claims 1,7,8,12,13; figure 13</td> <td>1-7</td> </tr> <tr> <td>X</td> <td>BE, A, 663872 (IGNAZIO FAILLA) 1 September 1965, see page 6, line 22 - page 7, line 10</td> <td>1-7</td> </tr> <tr> <td>A</td> <td>GB, A, 2154630 (K.K. MATSUZAWA KIKO) 11 September 1985</td> <td></td> </tr> </table>   |  |                                     | Category *   | Citation of Document, ** with Indication, where appropriate, of the relevant passages <sup>12</sup> | Relevant to Claim No. <sup>13</sup>                         | X  | DE, A, 2120691 (C. JEBENS) 9 November 1972, see page 7, line 6 - page 8, line 15; claim 1; figures 1-5 | 1-7 | X | EP, A, 0151389 (STUMP BOHR GMBH) 14 August 1985, see page 5, lines 1-7; page 13, line 19 - page 14, line 20; claims 1,7,8,12,13; figure 13 | 1-7 | X | BE, A, 663872 (IGNAZIO FAILLA) 1 September 1965, see page 6, line 22 - page 7, line 10 | 1-7 | A | GB, A, 2154630 (K.K. MATSUZAWA KIKO) 11 September 1985 |  |
| Category *  | Citation of Document, ** with Indication, where appropriate, of the relevant passages <sup>12</sup>  | Relevant to Claim No. <sup>13</sup> |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| X   | DE, A, 2120691 (C. JEBENS) 9 November 1972, see page 7, line 6 - page 8, line 15; claim 1; figures 1-5                                     | 1-7                                 |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| X   | EP, A, 0151389 (STUMP BOHR GMBH) 14 August 1985, see page 5, lines 1-7; page 13, line 19 - page 14, line 20; claims 1,7,8,12,13; figure 13 | 1-7                                 |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| X   | BE, A, 663872 (IGNAZIO FAILLA) 1 September 1965, see page 6, line 22 - page 7, line 10   | 1-7                                 |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| A   | GB, A, 2154630 (K.K. MATSUZAWA KIKO) 11 September 1985   |                                     |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| <div style="display: flex; justify-content: space-between;"> <div> <p>* Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div> |  |                                     |  |   |   |  |  |     |   |  |     |   |  |     |   |  |  |
| <b>IV. CERTIFICATION</b> <table border="1"> <tr> <td>           Date of the Actual Completion of the International Search<br/>           10th October 1989         </td> <td>           Date of Mailing of this International Search Report<br/>           9. 11. 89         </td> </tr> <tr> <td>           International Searching Authority<br/>           EUROPEAN PATENT OFFICE         </td> <td>           Signature of Authorized Officer<br/>           T.K. WILLIS         </td> </tr> </table>   |  |                                     | Date of the Actual Completion of the International Search<br>10th October 1989 | Date of Mailing of this International Search Report<br>9. 11. 89                                    | International Searching Authority<br>EUROPEAN PATENT OFFICE | Signature of Authorized Officer<br>T.K. WILLIS |  |     |   |  |     |   |  |     |   |  |  |
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ANNEX TO THE INTERNATIONAL SEARCH REPORT  
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| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                     | Publication<br>date  |
|---|---------------------|--|----------------------|
| DE-A- 2120691                             | 09-11-72            | None   |                      |
| EP-A- 0151389                             | 14-08-85            | DE-A,C 3400741<br>DE-A,C 3410830               | 18-07-85<br>03-10-85 |
| BE-A- 663872                              | 01-09-65            | CH-A- 466997<br>GB-A- 1110410<br>NL-A- 6506137 | -<br>15-11-65        |
| GB-A- 2154630                             | 11-09-85            | None   |                      |

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82